CLAIMS

That which is claimed is:

1. A composible and extensible library of stencils for developing a visual grammar for biological diagrams, each said stencil comprising:

graphical elements representing entities and at least one interaction; each said graphical element comprising biological semantics representative of a particular type of biological entity or interaction; and

slots for providing specific biological information, including specific entity names and directionality of interactions.

2. The library of stencils according to claim 1, wherein the visual grammar is represented in local format, enabling interactive functions to be performed among biological diagrams, textual documents and experimental data.

3. The library of stencils according to claim 2, wherein, when said slots are filled with said specific biological information, said specific biological information is automatically added to the local format.

4. The library of stencils according to claim 1, wherein said stencils can exist at multiple levels of abstraction, ranging from molecular interactions to higher-level biological concepts.

5. The library of stencils according to claim 1, wherein stencils can be composed hierarchically to compose relatively more complex stencils from relatively simpler stencils.

6. The library of stencils according to claim 1, wherein said stencils are collaboratively useable among multiple users.

7. The library of stencils according to claim 6, wherein collaborative use of stencils is afforded by at least one of the members of the group consisting of: providing a blank

set of stencils as a starter template, sharing of filled-in stencils, and collaboratively filling in stencils.

8. A system for manipulating biological data comprising:

a library of re-usable stencils for representing biological interactions;

means for selecting stencils to be populated with specific biological information;

means for assigning specific biological data to selected stencils; and

means for displaying stencils with the assigned specific biological data.

9. The system of claim 8, further comprising means for connecting common elements of said stencils with assigned specific biological data to display a biological diagram having said stencils as components thereof.

10. The system of claim 8, further comprising means for designing and saving additional stencils not previously contained in said library.

11. The system of claim 8, further comprising means for modifying, copying and/or deleting stencils contained in said library.

12. The system of claim 8, further comprising means for designing and associating rules with said stencils.

13. The system of claim 12, further comprising means for rule checking said rules to validate an interaction represented by a stencil containing specific biological data.

14. The system of claim 13, further comprising means for rule checking said rules against additional data.

15. The system of claim 14, wherein said additional data comprises data contained within a pre-existing biological diagram.

16. The system of claim 14, wherein said additional data comprises experimental data.

17. The system of claim 14, further comprising means for overlaying results of said rule checking on a network diagram.

18. The system of claim 8, further comprising means for navigating to data selected from said specific biological data and displayed on at least one of said stencils.

19. The system of claim 8, further comprising means for comparing, among two or more selected stencils, specific data assigned thereto and displaying results of said comparison.

20. The system of claim 19, wherein said displayed results are in terms of at least one of: differences and contradictions..

21. The system of claim 19, further comprising means for mapping between said selected stencils containing specific biological data and an existing biological diagram.

22. The system of claim 8, further comprising means for adding elements to a stencil on said canvas or creating a stencil on said canvas by freehand sketching by the user.

23. The system of claim 8, further comprising means for merging said stencils with a biological network and means for displaying s aid stencils merged with said biological network.

24. The system of claim 8, further comprising means for comparing a plurality of said stencils, using graph theoretic methods.

25. The system of claim 24, wherein said graph theoretic methods techniques to determine at least one characteristic selected from the group consisting of: a shortest path in a network; at least one spanning tree; degrees of connectedness; graph width; redundancy; redundant paths; alternative paths; graph traversal, identification of a subgraph, and identification of a motif structure within a graph.

26. The system of claim 8, further comprising means for linking the displayed stencils with other sources of biological data from which the specific biological data was extracted, using a local formatting language.

27. The system of claim 8, further comprising means for annotating at least a portion of at least one of said stencils.

28. The system of claim 27, wherein annotations produced by said means for annotating include at least one of the annotations selected from the group consisting of: freehand drawings, text, images, links to data, and data.

29. The system of claim 27, further comprising means for overlaying annotations produced by said means for annotating on a biological diagram.

30. A tool providing interactive capabilities for user involvement in disambiguating biological information and generating biological diagrams, said tool comprising:

a text viewer into which at least a portion of a textual document may be imported and viewed;

means for text mining the at least a portion of a textual document having been imported into the text viewer;

a list-based text editor that lists entities and interactions having been identified by said means for text mining;

a canvas area for generating biological diagrams;

at least one pre-designed blank stencil representing a particular type of interaction; and

means for populating stencils on said canvas with one or more of said entities and interactions identified by said means for text mining.

31. A tool for building biological networks of interactions, said tool comprising:

a text viewer into which at least a portion of a textual document may be imported and viewed;

means for text mining the at least a portion of a textual document having been imported into the text viewer;

a list-based text editor that lists entities and interactions having been identified by said means for text mining;

means for assigning directionality to the listed interactions; and

means for selecting interactions and associated entities in the list-based editor, merging common entities and displaying a resulting network of the interactions in said network viewer;

wherein said entities and associated entities are displayed visually using stencils that include display of directionality, and wherein said resulting network comprises a plurality of merged stencils.

32. A tool for comparing extracted biological knowledge against an existing static or dynamic biological diagram, said tool comprising:

a text viewer into which at least a portion of a textual document may be imported and viewed;

means for text mining the at least a portion of a textual document having been imported into the text viewer to identify biological concepts, entities, interactions and/or relationships that can be described by at least one predefined stencil;

a diagram viewer and means for importing at least a portion of an existing static or dynamic biological diagram into said diagram viewer;

means for overlaying at least one of said predefined stencils having been populated by at least one of said biological concepts, entities, interactions and relationships on said at least a portion of an existing biological diagram that is displayed in said diagram viewer;

and means for visually distinguishing the overlaid stencils from a remainder of the displayed biological diagram.

33. A method of graphically generating a biological diagram, said method comprising the steps of :

providing a stencil comprising graphical elements representing entities and at least one interaction and slots for providing specific biological information, including specific entity names and directionality of interactions;

providing a canvas area for generating and displaying biological diagrams;

assigning specific biological information to the stencil to identify entities involved in the interaction; and

displaying the stencil with assigned biological information on the canvas area.

34. A method comprising forwarding a result obtained from the method of claim 47 to a remote location.

35. A method comprising transmitting data representing a result obtained from the method of claim 48 to a remote location.

36. A method comprising receiving a result obtained from a method of claim 48 from a remote location.

37. A method of graphically generating a biological diagram, said method comprising the steps of :

providing a stencil comprising graphical elements representing entities and at least one interaction and slots for providing specific biological information, including specific entity names and directionality of interactions;

providing a canvas area for generating and displaying a biological diagram

assigning specific biological information to the stencil to identify entities involved in the interaction; and

interactively assigning the directionality of at least one interaction, thereby disambiguating a graphical representation of the interaction.

38. A method of providing interactive capabilities for user involvement in disambiguating biological information to be used in generating a biological diagram, said method comprising the steps of :

importing at least a portion of a textual document into a text viewer;

text mining the at least a portion of a textual document to identify biological entities and interactions;

providing a canvas area for generating biological diagrams;

providing at least one pre-designed blank stencil representing a particular type of interaction; and

populating a stencil on the canvas with one or more of said entities and interactions identified by said means for text mining, thereby assigning directionality to one or more interactions associating said entities.

39. A method of providing interactive capabilities for user involvement in disambiguating biological information to be used in generating a biological diagram, said method comprising the steps of :

importing at least a portion of a textual document into a text viewer;

text mining the at least a portion of a textual document to identify biological entities and interactions;

listing the identified entities and interactions in a list-based text editor; and

providing a canvas area for generating biological diagrams;

providing at least one pre-designed blank stencil representing a particular type of interaction; and

populating a stencil on the canvas with one or more of said entities and interactions identified by said means for text mining, including indicating directionality of at least one interaction represented by the stencil; wherein, upon populating the stencil, assignments of roles played by entities populating said stencil are automatically assigned in a list displayed by said list-based text editor.

40. A method for building biological networks of interactions, said method comprising the steps of:

importing at least a portion of a textual document into a text viewer;

text mining the at least a portion of a textual document having been imported into the text viewer;

populating entities and interactions having been identified by said text mining into stencils, thereby assigning directionality to the interactions associating the entities; and

selecting stencils containing interactions and associated entities, merging common entities among the selected stencils, and displaying a resulting network of the interactions resultant from said merging.

41. A method for interfacing textual knowledge graphically with biological networks, said method comprising the steps of:

importing at least a portion of a textual document into a text viewer;

text mining the at least a portion of a textual document having been imported into the text viewer;

populating entities and interactions having been identified by said text mining into stencils, thereby assigning directionality to the interactions associating the entities;

selecting stencils containing interactions and associated entities; and

overlaying the selected stencils on at least a portion of at least one existing biological diagram.

42. A method of parsing an existing biological diagram into stencils that are matched to subsets of the diagram, said method comprising the steps of:

identifying entities and interactions in the existing biological diagram;

identifying occurrences of patterns of the identified entities and interactions in the existing biological diagram having a frequency significantly greater than random occurrence; and

matching the frequently occurring patterns against elements of existing stencils.

43. A method of navigating through a corpus of biological knowledge sources or databases using partially filled-in stencils, said method comprising the steps of:

selecting at least one partially filled-in stencil;

automatically searching the corpus of biological knowledge sources or databases to locate members of the corpus that contain at least one entity or interaction that match the selected filled-in portion of stencil;

44. A method of annotating an other source of data such as mass spectra, scientific textual documents or other data, said method comprising:

providing a stencil comprising graphical elements representing entities and at least one interaction; and

linking the stencil with at least one of the other sources of data, using a local formatting language.

45. A method of inferring existing stencils via analysis of experimental data, wherein the experimental data comprises measures of differential quantities of biological entities relative to at least one reference sample, said method comprising the steps of:

deriving an expression pattern for each biological entity from a multiplicity of expression values over varying conditions contained in the experimental data;

comparing the expression patterns for similarity; and

determining whether any two expression patterns are similar, based upon a distance metric to obtain a similarity measurement, wherein similar expression patterns imply that the entities characterized by the similar expression patterns are co-regulated and therefore related in a biological interaction.

46. A computer readable medium carrying one or more sequences of instructions for generating a biological diagram, wherein execution of one or more sequences of instructions by one or more processors causes the one or more processors to perform the steps of:

providing a stencil comprising graphical elements representing entities and at least one interaction and slots for providing specific biological information, including specific entity names and directionality of interactions;

assigning specific biological information to the stencil to identify entities involved in the interaction; and

interactively assigning the directionality of at least one interaction, thereby disambiguating a graphical representation of the interaction.

47. A computer readable medium carrying one or more sequences of instructions for manipulating biological data comprising a library of re-usable stencils for representing biological interactions, wherein execution of one or more sequences of instructions by one or more processors causes the one or more processors to perform the steps of:

selecting stencils to be populated with specific biological information;

assigning specific biological data to selected stencils; and

displaying stencils with the assigned specific biological data.

48. A computer readable medium carrying one or more sequences of instructions for graphically generating a biological diagram, wherein execution of one or more sequences of instructions by one or more processors causes the one or more processors to perform the steps of:

providing a stencil comprising graphical elements representing entities and at least one interaction and slots for providing specific biological information, including specific entity names and directionality of interactions;

providing a canvas area for generating and displaying biological diagrams;

assigning , via annotation or via drag/drop from a data viewer, specific biological information to the stencil to identify entities involved in the interaction; and

displaying the assigned stencil on the canvas.

49. A computer readable medium carrying one or more sequences of instructions for disambiguating biological information to be used in generating a biological diagram, wherein execution of one or more sequences of instructions by one or more processors causes the one or more processors to perform the steps of:

importing at least a portion of a textual document into a text viewer;

text mining the at least a portion of a textual document to identify biological entities and interactions;

providing a canvas area for generating biological diagrams;

providing at least one pre-designed blank stencil representing a particular type of interaction; and

populating at least one of the blank stencils on the canvas with one or more of said entities and interactions identified by said means for text mining, thereby assigning directionality to one or more interactions associating said entities.

50. A computer readable medium carrying one or more sequences of instructions for building networks of biological interactions, wherein execution of one or more sequences of instructions by one or more processors causes the one or more processors to perform the steps of:

importing at least a portion of a textual document into a text viewer;

text mining the at least a portion of a textual document having been imported into the text viewer;

populating entities and interactions having been identified by said text mining into stencils, thereby assigning directionality to the interactions associating the entities; and

selecting stencils containing interactions and associated entities, merging common entities among the selected stencils, and displaying a resulting network of the interactions resultant from said merging.